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EXAMINER	
VALENCIA, DANIEL E	
ART UNIT	**PAPER NUMBER**
2874	

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Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 07-01)

Office Action Summary	Application No. 09/910,705	Applicant(s) LIBORI ET AL.
	Examiner Daniel E Valencia	Art Unit 2874

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____ .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-171 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-25 and 29-171 is/are rejected.

7)☒ Claim(s) 26-28 is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 20 July 2001 is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 4 .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

Application/Control Number: 09/910,705
Art Unit: 2874

DETAILED ACTION

Specification

The lengthy specification has not been checked to the extent necessary to determine the presence of all possible minor errors. Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

Drawings

JDL

The drawings are objected to because Figure 37 is really ~~10~~ two figures and should be labeled separately (e.g. 37(a) and 37(b)). A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Inventorship

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claim Objections

Claim 101 is objected to because of the following informalities: The claim is not a complete sentence ending with a period and fails to further limit the invention. The examiner is of the opinion that this is a typographical error and the intended limitation should read as originally filed. Appropriate correction is required.

Claims 109 and 128 are objected to. The examiner is of the opinion that the claims contain a typographical error and the units of the dimension should be microns. Appropriate correction is required.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in-
> (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effect under this subsection of a national application published under section 122(b) only if the international application designating the United States was published under Article 21(2)(a) of such treaty in the English language; or
> (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that a patent shall not be deemed filed in the United States for the purposes of this subsection based on the filing of an international application filed under the treaty defined in section 351(a).

Claims 1-11, 14-21, 33, 36, 38-40, 42-46, 48, 50, 51, and 53-63 are rejected under 35 U.S.C. 102(e) as being anticipated by Allan U.S. Patent No. 6,243,522. Refer to the appropriate drawings or parts of the specification. Allan discloses a photonic crystal fiber with all the limitations of the abovementioned claims. Regarding claim 1, Allan discloses a micro-structured optical fiber for transmitting at least a predetermined wavelength of light, said optical fiber having an axial direction and a cross section perpendicular to said axial direction, said optical

fiber comprising (see fig 3a): a core region (ref 14) having a multiplicity of spaced apart core features (ref 16) that are elongated in the fiber axial direction and disposed in a core material, said core region having an effective index of Nco , a cladding region (ref 18 and 20) surrounding said core region, said cladding region comprising a multiplicity of spaced apart cladding features (ref 10 and 22) that are elongated in the fiber axial direction and disposed in a first cladding material, and said cladding region having an effective index of refraction Ncl (col.2, lines 65-bottom), wherein a plurality of said cladding features have a cross sectional dimension perpendicular to said axial direction being larger than said predetermined wavelength (col. 3, line 5). Allan further discloses that the effective refractive index of the core region Nco is larger than the effective refractive index of the cladding region, Ncl, at a predetermined wavelength of light (col. 2, line 5), as mentioned in instant claim 2. With reference to claims 3-10, Allan discloses that the core and cladding features can have a larger or smaller refractive index than the material around it, depending on the concentrations of dopants (col. 3, lines 25-40). Allan further discloses that the predetermined wavelength is selected from wavelengths in the interval of 1.2 to 1.6 microns, and is about 1.3 microns (col. 5, lines 55-60), as mentioned in instant claims 11, 14, and 15. Regarding claims 16 and 17, Allan discloses that the predetermined wavelength can be selected from wavelengths in the interval of 1.5 to 1.6 microns, specifically 1.55 microns (col. 5, lines 55-60). Allan further discloses that the optical fiber transmits all the wavelengths within the range in single mode of propagation, as described in instant claims 18 and 19. Referring to claim 20, Allan discloses that the range can include wavelengths down to 0.3 microns (col. 5, line 55). Allan's disclosure depicts that the core features have cross section dimensions perpendicular to the axial direction being smaller than the cross sectional dimensions of the

cladding features (fig 3a), as explained in instant claim 21. With regards to claim 33, Allan discloses that the cladding features are periodical (col. 4,lines 30-35). Allan shows that the core features in the cross section occupy in total ration Fc of the core region, and the cladding features in the cross section occupy in total a ratio Fi of the cladding region and Fc is larger than Fi (fig 3a), as stated in claim 36. Referring to claim 38, Allan's disclosure depicts that the center-to-center spacing of the core features is smaller than the center-to-center cladding features (fig 3a). Allan's disclosure shows that the core region has 7 core features, as mentioned in instant claims 39 and 40. Regarding claims 42-44, Allan discloses that the core and cladding material can be made of silica (col. 3). Allan discloses that at least 60% of all the cladding features have a cross sectional dimension perpendicular to said axial direction being larger than the wavelength of the light guided by the fiber (col. 8, lines 55-60), as described in instant claim 45. With reference to claim 46, Allan discloses that the core region has a diameter larger than 2 microns (col. 4, lines 55-63). Allan further discloses that the cladding features have a diameter or cross sectional dimension being larger than 0.45 times the center-to-center spacing of said cladding features (example 2), as explained in instant claim 48. Regarding claim 50, Allan's disclosure shows that the core features occupy more than 5% of the cross section of the core region (fig 3a). Although Allan does not explicitly state that the core features can also be periodic, it would have been inherently disclosed by the reference, as mentioned in instant claim 51. Referring to claims 53-59, Allan discloses that the core and cladding features are rods made of silica, wherein the rods can be doped with one of the materials listed in claim 59 (see claim 22). Allan further discloses that the core or the cladding features can be voids, as described in instant claims 60-63 (see claim 17)

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claim 66-69, 74, 77, 80, 83, 87-89, 97, 98, 101, 102, 105, 108, 110, 115-119, 122-125, 130-138, 145-147, 151, 152, 154, 155, 157, 159-163, 167, 168, and 170 are rejected under 35 U.S.C. 103(a) as being unpatentable over DiGiovanni U.S. Patent No. 5,802,236 in view of DiGiovanni U.S. Patent No. 5,907,652. Refer to the appropriate drawings or parts of the specification. Regarding parts of claims 66-69, 89, and 131, DiGiovanni '236 discloses an article comprising a micro-structure optical fiber for (fig 5) guiding light at an operating wavelength, said optical fiber having an axial direction and a cross section perpendicular to said axial direction, the optical fiber comprising a core region (ref 51) surrounded by an inner cladding region (ref 52) that comprises a multiplicity of spaced apart inner cladding features (ref 52) that are elongated in the axial direction and disposed in an inner cladding material, the inner cladding region being surrounded by an outer cladding region (ref 53) that comprises a multiplicity of spaced apart outer cladding features that are elongated in the axial direction and disposed in an outer material, the inner cladding features having a refractive index that differs from a refractive index of the inner cladding material and the inner cladding region having an effective refractive index Ni and the outer cladding features having a refractive index that differs

from the refractive index of an outer cladding material and the outer cladding region having an effective refractive index No (col. 3). DiGiovanni further discloses that the core region is a substantially solid core (col. 3, line 14) made of core material and having an effective refractive index Nco being substantially equal to the refractive index of the core material, as explained in instant claim 74. With regards to claim 77, DiGiovanni discloses that the center-to-center spacing between inner and outer cladding features is substantially identical (col. 6). DiGiovanni's disclosure also shows that that at least part of the inner cladding features have a cross-sectional dimension being substantially identical to a cross-sectional dimension of at least part of the outer cladding features (see fig 5), as mentioned in instant claim 80. Referring to claims 83 and 157, DiGiovanni discloses that the refractive index of the inner cladding material is substantially identical to or larger than the refractive index of the outer cladding material (col. 3). DiGiovanni further discloses that the refractive index of some of the inner cladding features is lower than the refractive index of the inner cladding material, as mentioned in instant claims 87 and 88. With reference to claims 97 and 98, DiGiovanni discloses that the refractive index of some of the outer cladding features is lower than the refractive index of the outer cladding material (col. 5, lines 52-60). DiGiovanni further discloses that the refractive index of the core material is substantially identical to the refractive index of the inner cladding region and the outer cladding material (col. 3), as mentioned by instant claims 101 and 102. Regarding claim 105, DiGiovanni's disclosure shows that the outer cladding features occupy more than 30% of the cross section of the outer cladding region (fig 5). DiGiovanni discloses the inner and outer cladding features have a spacing in the range of about 0.1 to 10 times the wavelength of any light guided through the fiber (Example 2), as described in instant claim 110. Referring to claims

115-119, DiGiovanni discloses that some of both the inner and outer cladding features are voids filled with air, gases, or a vacuum (col. 11). DiGiovanni also discloses that some of the inner or outer cladding features can be glass or metal rods (col. 7, lines 25-35), as mentioned in instant claims 122-125. With regards to claim 66, 69, 130, 131, and 132, DiGiovanni discloses that the core region is a substantially solid core made of core material and having an effective refractive index Nco being larger than Ni at the operating wavelength. DiGiovanni further discloses that the effective refractive index difference between the core and the inner cladding is greater than about 5% (col. 8, lines 59-60), as mentioned in instant claim 133. Referring to claim 134, DiGiovanni discloses that the core region and the inner cladding region are mutually adapted so that the micro structured fiber exhibits a substantially zero dispersion or near zero dispersion wavelength within the range of 1.2 to 1.8 micron (see fig 6). DiGiovanni discloses that the center-to-center spacing or pitch of the inner cladding features is around or below 2 microns (col. 5, line 50), as mentioned in claims 131 and 135. With reference to claim 136, DiGiovanni's disclosure depicts that the number of inner cladding features is higher than or equal to 6. DiGiovanni's further discloses that the inner cladding features have a diameter or cross sectional dimension di and a center-to-center spacing Λi or pitch, fulfilling the requirement that di/Λi is in the range of 0.2 to 0.4 (col. 5, lines 40-60), as mentioned in claims 131 and 137. DiGiovanni further discloses that the center-to-center spacing of the outer cladding features is substantially equal to that of the inner cladding features (col. 5, lines 40-60), as described in instant claims 131, 138, and 145. Regarding claim 146, DiGiovanni discloses that the outer cladding features have a diameter or cross sectional dimension do fulfilling the requirement that do/Λo is equal to or below 0.7 and equal to or above 0.4 (col. 5, lines 40-60). DiGiovanni's disclosure further

states that the diameter of the core is around or below 4 microns (col. 5, line 52), as mentioned in instant claim 147. With reference to claim 151, DiGiovanni's disclosure states that the core, inner, and outer cladding can be composed of silica; therefore at least part of the core region has a refractive index being substantially identical to the refractive index of the inner or outer cladding region material. DiGiovanni also discloses that the core can be doped to raise the refractive index; thereby making the refractive index of the core region larger than the refractive index of the inner or outer cladding regions (col. 3, lines 25-45), as mentioned in instant claim 152, 160, and 161. Regarding claims 154 and 155, DiGiovanni discloses that the inner (and outer) cladding features are voids or rods having a lower refractive index than the inner (or outer) cladding material (col. 2, lines 12-32). In addition, DiGiovanni discloses that the some of the cladding features are voids containing air, another gas, or a vacuum (see Example 1), as mentioned in instant claim 159. Referring to claim 162, DiGiovanni discloses that the core or the cladding materials are photosensitive materials (col. 4, lines 5 and 6). DiGiovanni discloses that the fiber is dimensioned and could guide a light of predetermined wavelength in two substantially non-degenerate polarization states (col. 4, lines 26-32), as described in instant claim 163. With regards to claims 167 and 168, figure 5 of DiGiovanni's disclosure shows that the core region deviates substantially from a circular, quadratic, hexagonal, or polynomial shape in the fiber cross-section. DiGiovanni's disclosure does show that the core and cladding regions do have substantially 180-degree rotational symmetry, as explained in instant claim 170. DiGivanni '236 however; fails to teach that the inner cladding layer has a higher effective refractive index than the outer cladding layer.

On the other hand, DiGiovanni '652 discloses an article comprising an air-clad optical fiber that teaches the limitations that DiGiovanni '236 fails to teach. Regarding claims 66, 69, and 131, DiGiovanni discloses a microstructered optical fiber with a core, inner cladding and outer cladding region, wherein the effective refractive index of the core is greater than the effective refractive index of the inner cladding, and the effective refractive index of the inner cladding is greater than the effective refractive index of the outer cladding region (see fig 8 and col. 4, lines 48-64). DiGiovanni '652 further discloses that the diameter of the core is larger than 2 microns, as mentioned in instant claim 108. DiGiovanni '236 and DiGiovanni '652 both disclose similar micro-structured optical fibers for guiding lights at operating wavelengths. DiGiovanni '652 teaches that it would be advantageous to use an outer cladding layer with an effective refractive index that is less than that of the inner cladding, because it strengthens the fiber (col. 4, lines 54-bottom). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use an outer cladding with an effective refractive index that is less than that of the inner cladding layer in the fiber disclosed by DiGiovanni '236.

Claims 70-73 are rejected under 35 U.S.C. 103(a) as being unpatentable over DiGiovanni U.S. Patent No. 5,802,236 and DiGiovanni U.S. Patent No. 5,907,652 in view of IEEE article "Holey Optical Fibers: An Efficient Modal Model" (Monro et al). Refer to the appropriate drawings or parts of the disclosure. DiGiovanni as applied above, discloses an optical fiber for guiding light of a predetermined wavelength having micro structures in the inner and outer claddings, wherein the inner cladding has a larger effective refractive index than the outer

cladding. DiGiovanni however; fails to disclose a shifting wavelength at which the difference in refractive indexes changes.

On the other hand, Monro discloses a photonic crystal fiber that teaches the limitation that the DiGiovanni references lack. Regarding claims 70-73, Monro discloses that the effective index of refraction of the core and the cladding layers is wavelength dependent, such that the difference (Nco-Ncl) decreases and become substantially equal with wavelengths around a "shifting wavelength" (see pg 1093 column 2). It would follow that when the wavelength is shorter than said "shifting wavelength" Nco becomes substantially less than Ncl and vice versa. Immediately following the above description, Monro then states that "this results in a range of unique and potentially useful properties", such as the ability to tailor the mode volume. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a shifting wavelength in the optical fiber disclosed by DiGiovanni.

Claims 22-25, 29, 32, 35, 37, 41, 49, 52, 64, and 65 are rejected under 35 U.S.C. 103(a) as being unpatentable over Allan in view of Vali U.S. Patent No. 5,155,792. Refer to the appropriate drawings or parts of the specification. Allan as applied above, discloses a photonic crystal fiber with a majority of the limitations of the embodiment of the present invention. Referring to claim 65, Allan discloses that the core or cladding features are voids containing rare-earth material (claims 22-25). However, Allan fails to disclose the arrangement of the core features in the core region.

On the other hand, Vali discloses a low index of refraction optical fiber with tubular core and/or cladding that teaches various limitations that the Allan reference lacks. Regarding claims

22 and 23, Vali discloses that the core features have a center-to-center spacing being smaller than a predetermined wavelength, wherein the features can be smaller than 0.9 times the predetermined wavelength (col. 5, lines 59-65). Vali further discloses that the core features have a cross-sectional dimension perpendicular to the axial direction being smaller than the predetermined wavelength, wherein the dimension can be less than 0.9 times the predetermined wavelength (col. 5, lines 55-60), as described in instant claims 24 and 25. With reference to claim 32, Vali discloses that the core features in the cross section occupy in total a ratio Fc of the core region, and the cladding features in the cross section occupy in total a ratio Fi of the cladding region and Fc is smaller than Fi (col. 6, lines 24 and 25). Regarding claim 37, Vali's disclosure depicts that the core features have a center-to-center spacing substantially equal to that of the cladding layer (see figures). Vali's disclosure also depicts that the cladding features occupy at least 25% of the cross section of the cladding region, as mentioned in instant claim 49. Although Vali does not explicitly state that the spacing of the core or cladding features are in the range of about 0.2 to 10 microns as mentioned in claim 52, it is inherently disclosed when Vali explicitly states that the diameters and the spacings are smaller than the predetermined wavelength (normally around 1300nm or 1550 nm), considering a well known range of optical wavelengths from about 0.3 to 1.6 microns. Regarding claim 64, Vali discloses that the voids in the core or cladding contain air (col. 2, line 46).

Although Vali nor Allan explicitly state that the diameter of the core features is within the range in instant claim 29, this limitation would have been inherently disclosed in the combination of references. Allan discloses a range of wavelengths from about .3 to 2 microns for which the optical fiber transmits light and Vali disclosed that the core features are sized so

that they are smaller than the selected predetermined wavelengths (1300nm or 1550nm). Therefore, it would follow that the core features would be somewhere in the range described in claim 29. Referring now to claim 35, although neither of the references state that the core features have a dimension that is larger than the dimensions of the inner cladding features, the combination of references teach that the features can vary in spacing, diameter, and material, based on the desired effective refractive index; therefore, the relationship between diameters of the cladding and core features and the refractive indexes of region materials, as mentioned in claims 35 and 41, are non-critical, as long as the Nco > Ni is relationship is maintained. Vali and Allan both disclose optical fibers with microstructures with many of the same limitations. Vali teaches that it is advantageous to have core features that have a diameter smaller than the predetermined wavelength, wherein the spacing is also smaller than a predetermined wavelength, because it prevents undesirable diffusion of light into the cladding layer (col. 5, lines60-bottom). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the diameters and the spacings taught by Vali in the photonic fiber disclosed by Allan.

Claims 30, 31, and 34 are rejected under 35 U.S.C. 103(a) as being unpatentable over Allan in view of IEEE article "Holey Optical Fibers: An Efficient Modal Model" (Monro et al). Refer to the appropriate drawings or parts of the article. Allan as applied above, discloses a photonic crystal fiber with a majority of the limitations of the embodiment of the present invention; however, Allan fails to disclose that the fiber has a "shifting wavelength".

On the other hand, Monro also discloses a photonic crystal fiber that teaches some of the limitations that the Allan reference lacks. Regarding claim 30, 31, and 34, Monro discloses that the effective index of refraction of the core and the cladding layers is wavelength dependent, such that the difference (Nco-Ncl) decreases and become substantially equal with wavelengths around a "shifting wavelength" (see pg 1093 column 2). It would follow that when the wavelength is shorter than said "shifting wavelength" Nco becomes substantially less than Ncl and vice versa. Immediately following the above description, Monro then states that "this results in a range of unique and potentially useful properties", such as the ability to tailor the mode volume. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a shifting wavelength in the optical fiber disclosed by Allan.

Claims 75, 76, 78, 79, 81, 82, 84, 85, 86, 90-96, 99, 100, 103, 104, 106, 107, 113, 114, 120, 121, 126-129, 140-144, 148-150, 153, 156, 158, 165, 166, and 171 are rejected under 35 U.S.C. 103(a) as being unpatentable over DiGiovanni 5,802,236 and DiGiovanni 5,907,652 in view of Allan U.S. Patent No. 6,243,522. Refer to the appropriate drawings or parts of the specification. DiGiovanni as applied above, discloses an optical fiber for guiding light of a predetermined wavelength having micro structures in the inner and outer claddings, wherein the inner cladding has a larger effective refractive index than the outer cladding. Regarding claim 94, DiGiovanni '236 discloses that the refractive index of the inner cladding material is substantially equal to the refractive index material of the outer cladding material, because they are both made of silica. DiGiovanni '236 further discloses that the core region has a two fold-symmetry, which is non-circular depending on the arrangement of the voids in the inner cladding

(fig 5), as seen instant claims 165, 166, and 171. With reference to instant claim 84, DiGiovanni's disclosure depicts that the feature to region ratio of the inner cladding is greater than the feature to region ratio of the outer cladding (fig 5). DiGiovanni however; fails to disclose that the fiber has core features.

On the other hand, Allan also discloses a photonic crystal fiber that teaches some of the limitations that the combination of the DiGiovanni references fails to teach. Regarding claims 75 and 90, Allan discloses that the core region comprises a multitude of spaced apart core features elongated in the axial direction and disposed in core material (fig 3a). Allan discloses that the refractive index of the inner cladding features can be higher (if doped) than the index of the inner cladding material (col. 5), as described in instant claims 85 and 86. With reference to claims 99 and 100, Allan discloses that the core features are glass rods with a refractive index that depends on whether or not they are doped (col. 3, 21-40), and in some cases can be voids (claim 17), therefore allowing the features to have an index lower than or larger than the surrounding core region. Allan's disclosure depicts that the core features are smaller than the inner cladding features, wherein the spacing of the core features is also smaller (fig 3a), as mentioned in claims 103 and 104. Regarding claims 106 and 107, Allan discloses that the core or cladding features can be arranged periodically (col. 4, lines 30-37). Allan further discloses that the core features can be voids or rods (see claims 17 and 18), as mentioned in instant claims 113, 114, 120, and 121. Allan discloses that the core or cladding features are voids containing materials providing an increased third-order nonlinearity, a photosensitive material, or a rare earth material, as mentioned in claim 126 (claims 22-25). Referring to claims 127-129, Allan discloses that the fiber guides light of predetermined range of wavelengths, set aside in instant

claim 128, in a single mode (col. 5,lines 46-60). Allan further discloses that the refractive index of the core can vary along the diameter, because of different core features having different refractive indexes, therefore creating a segmented core refractive index profile (col. 3, lines 20-40), as described in instant claims 148-150.

DiGiovanni discloses a microstructured optical fiber that uses voids as a means of lowering effective refractive indexes to create a desirable difference between layers. Allan discloses a microstructured optical fiber that uses doped silica rods as a means of raising effective refractive indexes to create a desirable difference between layers. Both references teach that the size of the features in different layers depend on wavelength, and desired feature to region ratio, in order to create desired index. Since DiGiovanni discloses a fiber in which voids (of lower refractive index than the surrounding region), are used to lower effective refractive index, wherein the outer cladding voids are smaller in dimension than the inner cladding voids; if the optical fiber used up-doped silica rods instead as taught by Allan, the inner cladding's features would necessarily be smaller in dimension, thus creating a smaller feature to region ratio in the inner cladding than in the outer cladding, than those of the outer cladding region, in order to maintain the Nco > Ni > No relationship, as explained in instant claims 76, 79, 81, 95, 96, 156, and 158. Furthermore, the number of features in the cladding and the center-to-center spacings, mentioned in instant claims 82 and 140-144, are non-critical limitations of the invention. DiGiovanni teaches 6 features in the cladding, but the number of features necessary varies according to desired effective refractive index, refractive index of the surrounding region, and refractive index of the features themselves.

Regarding claims 78, 91-93, and 153, DiGiovanni and Allan discloses multilayered microstructured fiber with different refractive indexes, that are dependent upon the features disposed in each layer and the refractive index of the surrounding layers. DiGiovanni '236 specifically discloses that the refractive indexes of the materials of the cladding layers and the core can have a variety of relationships depending on whether or not the layer is doped (col 3) as long as the effective refractive index maintains the relationship of Nco > Ni > No. Any of the combinations mentioned in the instant claims, would be obvious variations of the prior art.

Claims 139, 164, and 169 are rejected under 35 U.S.C. 103(a) as being unpatentable over DiGiovanni U.S. Patent No. 5,802,236 and DiGiovanni U.S. Patent No. 5,907,652 in view of PCT international application publication No. WO 00/49436 (Russell et al). Refer to the appropriate drawings or parts of the disclosure. DiGiovanni as applied above, discloses an optical fiber for guiding light of a predetermined wavelength having micro structures in the inner and outer claddings, wherein the inner cladding has a larger effective refractive index than the outer cladding. DiGiovanni however; fails to disclose some of the limitations of the present invention.

On the other hand, Russell discloses improvements relating to photonic crystal fibers that teaches the limitations that the DiGiovanni references lack. Regarding claim 139, Russell's disclosure depicts that the cross sectional dimensions of the inner and outer cladding can be substantially identical (fig 5 and 6). Russell further discloses that the fiber is characterized by birefringence of at (pg. 4, lines 4-6) least 10^{-5}, as mentioned in instant claim 164. Referring to claim169, Russell discloses that the shape of the core region is substantially rectangular in the

fiber cross-section (pg. 15, line 34 and fig 5, 6, and 10). Both Russell and DiGiovanni disclose similar multi-layer photonic crystal fibers, with many of the same limitations. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to combine the DiGiovanni references with the photonic crystal fiber disclosed by Russell.

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Claims 12, 13, and 47 ~~is~~ are rejected under 35 U.S.C. 103(a) as being unpatentable over Allan and Vali in view of Birks PCT international application publication No. WO 99/00685. Refer to the appropriate drawings or parts of the specification. Allan and Vali as applied above, disclose a microstructured optical fiber with a majority of the claimed limitations of the present invention. Allan and Vali however; fail to teach the specific diameter of the core region.

On the other hand, Birks discloses a single mode optical fiber that teaches the limitations that the combination of Allan and Vali fails to teach. Regarding claim 47, Birks discloses that diameter of the core region is between 2 and 50 microns (pg 12). Birks further discloses that a predetermined wavelength can be about 600 nm (pg. 19), as mentioned in instant claim 12. Referring to claim 13, although Birks does not explicitly state that his microstructured fiber transmits wavelengths around 780, 980, or 1060 nm, it would be inherently disclosed in the reference, when Birks teaches that the device transmits fiber amplifier pump (pg. 7) radiation (these wavelengths are known to be around 980 nm). Birks, Vali, and Allan all disclose optical fibers with microstructures, with many of the same limitations. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to combine the Birks, Vali, and Allan references.

Claim 109 is rejected under 35 U.S.C. 103(a) as being unpatentable over DiGiovanni U.S. Patent No. 5,802,236 and DiGiovanni U.S. Patent No. 5,907,652 in view of Birks PCT international application publication No. WO 99/00685. Refer to the appropriate drawings or parts of the disclosure. DiGiovanni as applied above, discloses an optical fiber for guiding light of a predetermined wavelength having micro structures in the inner and outer claddings, wherein the inner cladding has a larger effective refractive index than the outer cladding. DiGiovanni however; fails to disclose a specific core diameter.

On the other hand, Birks discloses a single mode optical fiber that teaches the limitations that the combination of DiGiovanni references fails to teach. Regarding claim 109, Birks discloses that diameter of the core region is between 2 and 10 microns (pg 12). Birks and DiGiovanni disclose optical fibers with microstructures, with many of the same limitations. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to combine the Birks and DiGiovanni references.

Claims 111 and 112 are rejected under 35 U.S.C. 103(a) as being unpatentable over DiGiovanni U.S. Patent No. 5,802,236 and DiGiovanni U.S. Patent No. 5,907,652 and Allan in view of Vali U.S. Patent No. 5,155,792. Refer to the appropriate drawings or parts of the specification. DiGiovanni and Allan as applied above, discloses an optical fiber with micro structures with a majority of the limitations of the present invention; however the reference fails to disclose the relationship between feature diameter and center-to-center spacing.

On the other hand, Vali discloses a low index of refraction optical fiber with tubular core or cladding that teaches the limitations that these references lack. Regarding claims 111 and

112, Vali discloses that the core features have spacings that are smaller than the predetermined wavelength; therefore, being between 0.1 to 10 times the wavelength, and falling within the range of 0.1 to 10 microns (col. 5, lines 55 to bottom). Vali teaches that it is advantageous to use spacing among the features that is less than the predetermined wavelength, because it prevents undesirable diffusion. Therefore, it would have been obvious to use the center-to-center spacing disclosed in Vali in the device disclosed by DiGiovanni and Allan.

Allowable Subject Matter

Claims 26-28 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The following is a statement of reasons for the indication of allowable subject matter: As to dependent claim 26, the prior art of record, taken alone or in combination, fails to disclose or render obvious a microstructured optical fiber according to claims 21-25, wherein the cores features have a cross sectional dimension perpendicular to said axial direction being so large that a second order mode of propagation is shifted to a wavelength of light being shorter or smaller than a predetermined wavelength.

Conclusion

The prior art documents submitted by the applicant in the Information Disclosure Statement filed on January 29, 2002, have all been considered and made of record (note attached copy of form PTO-1449).

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Daniel E Valencia whose telephone number is (703)-305-4399. The examiner can normally be reached on Monday-Friday 9:30-6:00.

The fax phone numbers for the organization where this application or proceeding is assigned are (703)-308-7724 for regular communications and (703)-308-7724 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703)-308-0956.

DV
Dan Valencia
October 17, 2002

John D. Lee